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14. ABSTRACT
We have organized a team of subject matter experts & engaged in the iterative process. Our clinical team chose a supermarket as the virtual scenario where veterans could receive cognitive & emotional challenges (create & follow a shopping list, purchase items, make change, shopping cart collisions, disputes at check out). A virtual supermarket was constructed that allows a therapist & patient, each at their own computer, to enter the virtual supermarket together, to choose items from shelves & place them in a cart. The therapist can allocate money that is placed in virtual wallet, can animate other avatars such as the cashier, can chose the noise level and the number of shoppers in the environment, as well as their appearance. A virtual personal digital assistant (PDA) is available to the shopper Conclusions: TherapeuticVWEs for mTBI /PTSD are feasible, & show great promise to fill treatment gaps in current care delivery. Not only are new therapeutic milieus possible, but therapy can be delivered to patients regardless of distance with VWEs. Impact: This project shows great potential to expedite & expand care to veterans & wounded warriors in a short time frame, & in a cost effective manner.

15. SUBJECT TERMS
Traumatic brain injury, post-traumatic stress disorder, virtual reality

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Introduction

The symptoms of TBI (which often are accompanied by post-traumatic stress disorder) include disturbances in attention and memory, as well as impaired cognitive processing. Often the most troubling symptoms are behavioral: mood changes, depression, anxiety, impulsiveness, and emotional outbursts. Intolerance of crowds and hyper-vigilance are also common. Behavioral therapy, a mainstay of rehabilitation treatment, generally requires that veterans be able to organize and negotiate daily activities and interact with the general public to meet scheduled appointments, stressing the very areas where many are profoundly impaired. New therapeutic options that can be delivered to veterans at home, and that can augment current processes are needed. Fortunately, virtual world environments (VWEs) hold the potential to answer these concerns. VWEs are easily accessible, intuitive, and effective forms of virtual reality that provide secure real-time interaction between multiple users. Many younger warriors are not only familiar with, but comfortable and fluent in virtual realities through their exposure to electronic gaming. The goal of this concept award was to 1) build working teams of clinicians and computer experts to collaborate to conceptualize a relevant, therapeutic VWE for returning combat veterans. 2) Construct a working prototype VWE that could be occupied by a therapist and patient simultaneously.

Body

The goals of this proof-of-concept award was to develop a working prototype of a VWE that could augment traditional cognitive therapy for combat veterans with mTBI. To accomplish this, we used the principles articulated by Bisgaard, Iansiti, Menon and Hippel et al [1-4] to assemble an interdisciplinary group of investigators with broad clinical and technical expertise to engage in an iterative and recursive process to develop our prototype VWE.

1) Teams: We assembled a working group composed of three physiatrists, one physical therapist, two neuropsychologists, a psychologist, an advanced nurse practitioner, an arts-in-medicine specialist, a digital media artist, two graduate assistants, and a technical director.

2) Process: We divided our group into two teams and added an advisory panel. Our multidisciplinary clinical team (CT) was made up of our clinician investigators, with each member actively engaged in evaluating and treating combat veterans from Operation Enduring Freedom (Afghanistan)/Operation Iraqi Freedom; Our Technology Team (TT), was comprised of the remaining members, all of whom had experience creating VWE for therapeutic purposes. The advisory Panel was made up of national experts in VR, telehealth, and mental health.

In the first 2 months, the CT met with the TT three times to establish overall project goals, and to establish the roles and responsibilities of each team. During this period, the CT briefed the TT on the problems facing returning combat veterans with mTBI, and the TT discussed and demonstrated the capacities of the Digital Worlds Institute and VWEs. Following this initial period, The CT began meeting twice a month to brainstorm how the VWEs might be developed to help in the rehabilitation of mTBI. The CT then would brief the TT every 4-6 weeks. With the input of the TT, the clinical team was able to sharpen and focus its vision to imagine scenarios that would take advantage of the unique capacities of VWEs, and that were realistic given the time and resources allocated to the TT.

The CT considered three promising scenarios. A grocery store that could offer computational, navigational, and memory challenges, and a home environment that would involve planning for the day and travel through an urban environment, were considered. A different type of scenario, a “build-it-yourself “ virtual Iraq that would challenge veterans to remember and process their wartime experiences while teaching them design and computer skills that might be useful vocationally was also considered. With the help of the TT, the “build-it-yourself” scenario was

judged to be both impractical and somewhat duplicative of existing VR applications. The grocery store was ultimately preferred to the home environment because it was felt to be a common environment, which could easily present multiple levels and types of cognitive tasks and emotional challenges that are often vexing to those with mTBI/PTSD. The home scenario was felt to be harder to standardize and was felt to have less flexibility

Through this process, the following work plan emerged:

1) Build the virtual grocery environment starting with floor, walls, and empty shelves
2) Fill the shelves with items and decorate the environment in consistent with a grocery store
3) Build a functioning aisle, with a variety of grocery items that can be selected
3) Build avatars that can be "inhabited" by therapists and patients, and directed by joystick control
4) Equip the avatars with grocery carts into which selected items can be placed
5) Create a variable number of "bots" (animated people who roam the store autonomously)
6) Create a virtual wallet which can be filled with a variable amount of money as determined by the therapist.
7) Create ambient noise that can be either increased or decreased at the therapist's discretion
8) Create a collision between shopping carts. Allow this to be either minor or major
9) Allow the therapist to switch between different avatars such as a shopper or a cashier, depending on the therapeutic scenario.

At of these goals have been met (Figure 1). In addition, the AP has also met to evaluate the progress to date and give further suggestions. Currently they are satisfied with the direction and progress to date, and urge us to seek further funding to continue our work.

Figure 1 a: Two avatars shopping

Figure 1 b: An aisle of the store.

Key Research Accomplishments

- Development of an iterative team structure that allowed trans disciplinary conceptualization and implementation of a prototype virtual grocery store.
- Construction of a prototype VWE that allows
    - The therapist and veteran to traverse the grocery store together each occupying distinct avatars
    - The therapist to switch to a third avatar, the cashier
    - The therapist to set parameters such as:
        - Money in a virtual wallet,
        - Number of other autonomous avatar shoppers,
        - Ambient noise level
        - Collision with another shopper.

Reportable Outcomes

Presentations: Levy CE, Oliverio J, Sonke J, Hundersmarck T, Demory J, Tassin C, Sinclair A, Scott-Okafor H, Omura D
Virtual Environments for Cognitive and Affective Dysfunction in Mild Traumatic Brain Injury and Post-Traumatic Stress Disorder: Development of a 21st Century Treatment Platform. Military Health Research Forum (MHRF) Kansas City, Missouri, 9.09

Letter of intent to CDMRP: PT090225 Virtual Environments and Virtual Humans for TBI and PTSD: Status: Not accepted PICharles E. Levy, MD

Letter of Intent to DMRDP: Assessment of Executive Functioning Domains in 3 Ecologically Valid Modalities: Principal Investigator: Tatjiana Novakovic-Agopian, PhD. Co-PI: Charles E. Levy, MD Submitted 9.09

VA RR&D: 1I01RX000339-01 Virtual Environments for Therapeutic Solutions (VETS) mTBI/PTSD Phase II: Submitted 6.09. PI: Charles E. Levy, MD Status: Pending

Conclusion

We have successfully built and demonstrated a VWE prototype with a host of features deemed relevant by clinicians treating returning combat veterans with PTSD/TBI. The next steps would be further development, refinement, clinical trials and technical transfer.

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Appendices

The following individuals received pay from this research effort:

James Charles Oliverio

Patrick Ralph Pagano

Arturo Sinclair

Jill K. Sonke

The following poster was presented at the Military Health Research Forum (MHRF) Kansas City, Missouri, September 2009

Virtual Environments for Cognitive and Affective Dysfunction in mTBI and PTSD: Development of a 21st Century Treatment Platform. Phase 1 Proof of concept.

Charles E. Levy, [1,3]; James Oliverio[3], Jill Sonke[4], Thomas Hundersmarck[2], Jason Demery[2], Christian Tassin[3], Arturo Sinclair[3], Hellena Scott-Okafor[2] and David Omura[2].

[1]North Florida Foundation for Research and Education, [2]North Florida/South Georgia Veterans Health System, [3]Digital Worlds Institute, University of Florida; [4] Center for Arts in Healthcare Research & Education, University of Florida, Gainesville, Florida

Abstract

Background & Objectives: This is a progress report on a concept award.
The prevalence of mild traumatic brain injury (mTBI) & post-traumatic stress disorder (PTSD) in returning combat veterans is estimated at nearly 20% for each condition. The mainstays of treatment for the cognitive & affective sequellae of mTBI /PTSD are pharmacology & psychotherapy. Unfortunately, traditional psychotherapy demands repeated travel to a clinic which is impractical & of limited benefit for many. Although there is emerging evidence that use of virtual reality may contribute greatly to MTBI/PTSD rehabilitation, its use in combat veterans is rare, (usually limited to portraying battle as a part of exposure therapy). Our goal is to leverage combat veterans' comfort & familiarity with communications technology & immersive environments (through cell phones, internet & video games) by building a prototype of a therapeutic virtual world environment (VWE) The VWE will simulate everyday life encounters that are challenging to those with mTBI/PTSD, & allow the veteran & therapist to confront & overcome barriers that block successful social reintegration. Objectives: 1) convene an expert team of physicians, nurses & therapists, as well as university-based digital artists, arts-in-medicine, computer engineering specialists; 2) Engage in a structured iterative process of conceptualizing, creating & modifying Therapeutic VWEs to create a proof-of-concept prototype that is intuitive, & accessible.
Results to date: We have organized a team of subject matter experts & engaged in the iterative process. Our clinical team chose a supermarket as the virtual scenario where veterans could receive cognitive & emotional challenges (create & follow a shopping list, purchase items, make change, shopping cart collisions, disputes at check out). A virtual supermarket is under construction that allows a therapist & patient, each at their own computer, to enter the virtual supermarket together, to choose items from shelves & place them in a cart, & to have collisions with other shoppers. Further enhancements are under development.
Conclusions: Therapeutic VWEs for mTBI /PTSD are feasible, & show great promise to fill treatment gaps in current care delivery. Not only are new therapeutic milieus possible, but therapy can be delivered to patients regardless of distance with VWEs.
Impact: This project shows great potential to expedite & expand care to veterans & wounded warriors in a short time frame, & in a cost effective manner.

Scope of the Problem

- TBI: 1.4 million/year in the US [1]
- US has deployed > 1.6 million military personnel to Iraq and Afghanistan [2]
- 18.5% of returning service members meet criteria for PTSD [2]
- 19.5% of returning service members meet criteria for a probable TBI [2]
- As of 2008, 2 5,000 Soldiers ha ve be en diagnosed with TBI. Projected cost of care = $14 billion

Symptoms of TBI/PTSD = Barriers to Care

- Deficits in Attention and Memory
- Impaired Cognitive Processing.
- Anxiety, Impulsiveness, and Emotional Outbursts
- Intolerance of Crowds, and Hyper-Vigilance

Potential of Virtual World Environments

- Easy Access
- Well Accepted by Younger Warriors Familiar with Video Gaming
- Safe, Controlled Environment
- Infinite Repetitions = Infinite Practice
- Play Back to Examine Different Points of View
- Eliminates Travel
- Cognitive and Emotive Challenges
- Scalable Task Complexity (simple lists to complex tabulations/item substitutions, unexpected interactions with other shoppers).
- Scalable Distracters (Noise level, Lighting, appearance and number of fellow shoppers).

Scenes from a Therapeutic VWE

Figure 1a. Simulated Veteran with Avatar

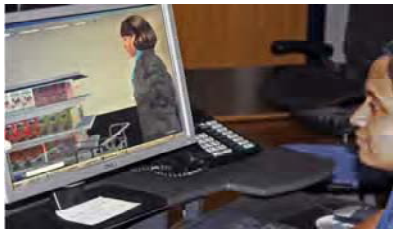

Figure 1b. Simulated Therapist with Avatar

Figure 1c. Veteran and Therapist Avatars in Store

Figure 1d. Grocery Cart Collision. Therapist Menu at Top

Figure 1e. "Bot" shopper

Figure 1f. Checkout. Veteran Menu at Top

Methods and Procedure

Our Goals are to develop a working prototype of a Virtual World Environment (VWE) that could augment traditional psychotherapy for combat veterans with mTBI/PTSD. We used the principles of Bisgaard, Iansiti, Menon and Hippel et al [3-6] to assemble an interdisciplinary group of investigators

1) Teams: Our working group is composed of three physiatrists, one physical therapist, two neuropsychologists, a psychologist, an advanced nurse practitioner, an arts-in-medicine specialist, a digital media artist, two graduate assistants, and a technical director.

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5) Create a variable number of "bots" (avatars that roam the store autonomously).
6) Create a virtual wallet filled with a variable amount of money as determined by the therapist.
7) Develop a virtual personal digital assistant (PDA) to assist the patient.

Results and Conclusion

The above g oals h ave b een achieved, d emonstrating the in itial f easibility of the concept. I n ad dition, working teams have been established, as well as a working methodology for collaboration across the teams. We conclude t hat t herapeutic VWEs developed b y a team of clinicians and d igital technical ex perts are possible, and show great promise to augment the treatment of mTBI/PTSD, and thus enhance the lives of warriors.

Next Steps

Phase 1

- Upgrade the store:
  - Joystick control
  - Two-way Videoconferencing
  - Enhance "production values"
- Develop additional Virtual World Environments
- Develop Virtual Humans
- Engage in further iterative cycles of warrior and clinician feedback
- Develop a technical manual

Phase 2

- Pilot Studies
- Randomized Controlled Studies
- Platform for Development/Collaboration
- Technical Transfer

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